Chapter 7.1

Abundance and frequency of occurrence of brown tide, *Aureococcus anophagefferens*, in the Maryland Coastal Bays

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Abstract

Aureococcus anophagefferens, the micro-organism that causes brown tide, was first identified in the United States in 1987 and first discovered in Maryland during 1998, though recent research indicates that it was present since at least 1993. Brown tide blooms have been categorized based on their potential impacts to living resources [categories 1 (lowest), 2, and 3 (highest)]. Brown tide is a problem in the Coastal Bays, occurring at category 3 levels in at least one Coastal Bays segment annually since 1999.

Introduction

Brown tide**,** *Aureococcus anophagefferens,* blooms can have serious impacts on shellfish populations (scallops, hard clams, and mussels) and seagrasses. Brown tides of this species have occurred in the northeastern United States and western Africa. *A. anophagefferens* was first identified in the United States in Narragansett Bay, Rhode Island in 1987 and discovered in Maryland during 1998 (Gastrich and Wazniak 2000). Data collected by the National Park Service (NPS) showed *A. anophagefferens* was present in the Coastal Bays since at least 1993 based on the presence of a pigment unique to this algal species detected in archived NPS samples (Trice et al. 2004). No samples were available for the period prior to 1993.

Monitoring

Since 1999, the Maryland Department of Natural Resources' brown tide (BT) program monitored 15 stations throughout the Coastal Bays. Results revealed that blooms tend to occur in late spring and early summer (May-July). Brown tide was found in all Coastal Bays segments, however, an area in the southern bays from Newport Bay to Public Landing across to Tingles Island consistently had the highest levels. Scientists classify BT blooms similar to hurricanes Category 1, 2 and 3 (Gastrich and Wazniak 2000) with 3 having the most serious environmental impacts (Table 7.1.1).

Table 7.1.1: Brown tide categories and potential ecological impacts.

Category	*Aureococcus* concentration	Potential Ecosystem Impacts
1	<35,000 cells*ml^{-1}	• No observed impacts
2	35,000 to < 200,000 cells*ml^{-1}	• Reduction in growth of juvenile hard clams, (*Mercenaria mercenaria*). • Reduced feeding rates in adult hard clams. • Growth reduction in mussels (*Mytilus edulis*) and bay scallops (*Argopecten irradians*).
3	≥ 200,000 cells*ml^{-1}	• Water becomes discolored yellow-brown. • Feeding rates of mussels severely reduced. • Recruitment failures of bay scallops. • No significant growth of juvenile hard clams. • Negative impacts to eelgrass due to algal shading. • Copepod production reduced and negative impacts to protozoa.

Analysis

Water samples from existing Maryland Department of Natural Resources (DNR) and Assateague Island National Seashore (ASIS) stations were tested for brown tide during putative bloom season from 1999 through 2001 (Figure 7.1.1). Brown tide season was considered to be late May through mid-July. Since 2001, DNR has added late September through early November as a possible second annual season for brown tide. Samples were microscopically counted for brown tide concentration by A. Hertzig at the American Academy of Natural Science Estuarine Research Center. Peak brown tide concentrations for each of the three years were averaged for each sample station, categorized as per Table 7.1.1, and reported as the three-year brown tide status for each station. Results from 2002 and 2003 sample years are reported in the following text, but were not a part of the status calculation.

Results

Bloom intensity and distribution varied annually across the Coastal Bays. The three-year status of maximum blooms is presented as a summary (Figure 7.1.1). More about annual and interannual variability is available from DNR datasets (Wazniak 2004).

Descriptions of the blooms in each of the years monitored through 2003 are given below. All station locations refer to those shown in Figure 7.1.1.

1999 Category 2 blooms were broadly distributed including Montego Bay, Ocean Pines canal, and all of the southern bays. A Category 3 bloom in Newport Bay produced the highest concentrations of the year in mid-June (>450,000 cells*ml^{-1}); lowest concentrations were found in Virginia (Figure 7.1.2). Blooms peaked between late May and mid-June depending on area (differences between north and south) and ended in early July. Highest brown tide concentration was observed in Newport Bay in mid-June (>450,000 cells*ml^{-1}).

2000 No significant blooms were detected in the northern bays while Category 3 blooms were found in Newport Bay and at Public Landing and Tingles Island stations (Figure 7.1.3). Bloom levels peaked at the end of May and declined by the end of June. The highest concentration was observed at Public Landing on May 29 (~900,000 cells*ml^{-1}).

2001 No significant blooms were found in the Northern Bays while Category 3 blooms were detected at Newport Bay and Public Landing, and Category 2 at Tingles Island stations (Figure 7.1.4). Bloom levels peaked in mid-June and ended in late June. The highest concentration was observed at Public Landing on June 13 (680,793 cells*ml^{-1}).

2002 Category 2 blooms were extensive throughout the bays except at Nixon, VA, Taylors Landing, and XDN7646 (Figure 7.1.5). Blooms peaked late May to mid-June and ended by late June. The highest concentrations were observed at an aquaculture facility in Chincoteague Bay, where a Category 3 bloom occurred (>200,000 cells*ml^{-1}; note that the aquaculture facility is not the Public Landing station indicated on Figure 7.1.1). All-time high levels for the monitoring program were measured in Isle of Wight (XDN3445) and Manklin Creek (MKL0010).

2003 No significant blooms were found in the northern Coastal Bays. In contrast, the southern bays experienced the most spatially and temporally extensive bloom since the beginning of the monitoring program in a year where no other areas in the northeastern U.S. experienced brown tides. This bloom peaked in June and ended in mid-July. The highest concentration was at Green Point on June 10 (745,408 cells*ml^{-1}) (Figure 7.1.6). Record high concentrations were observed in the southern bays (Ferry Landing, Green Point, Taylors Landing, Pirate Islands, and Nixon, VA). (Figure 7.1.6)

Summary

During the last several years, brown tide was the predominant harmful algal bloom species, exceeding published threshold levels (Gastrich and Wazniak 2002) in the Coastal Bays from 1999 through 2003. In 2000, 2001 and 2003 no significant blooms were observed in the northern Bays while the southern Bays experienced Category 3 blooms.

The years 1999 and 2002 had category 2 blooms in the northern and southern bays. The southern bays were affected by Category 3 blooms every study year. In 2003, an extensive bloom (temporally and spatially) occurred in the southern bays when no other area in the northeastern United States reported brown tides.

References

Gastrich, M.D. and C.E. Wazniak. 2002. A brown tide bloom index based on the potential harmful effects of the brown tide alga, *Aureococcus anophagefferens*. Aquatic Ecosystem Health and Management 5: 435-441.

Trice, T.M., P.M. Glibert, C. Lea, and L. Van Heukelem. 2004. HPLC pigment records provide evidence of past blooms of *Aureococcus anophagefferens* in the coastal bays of Maryland and Virginia, USA. Harmful Algae 3: 295-304.

Wazniak, C.E. 2004. Brown tides. Website: http://www.dnr.state.md.us/coastalbays/bt_results.html.

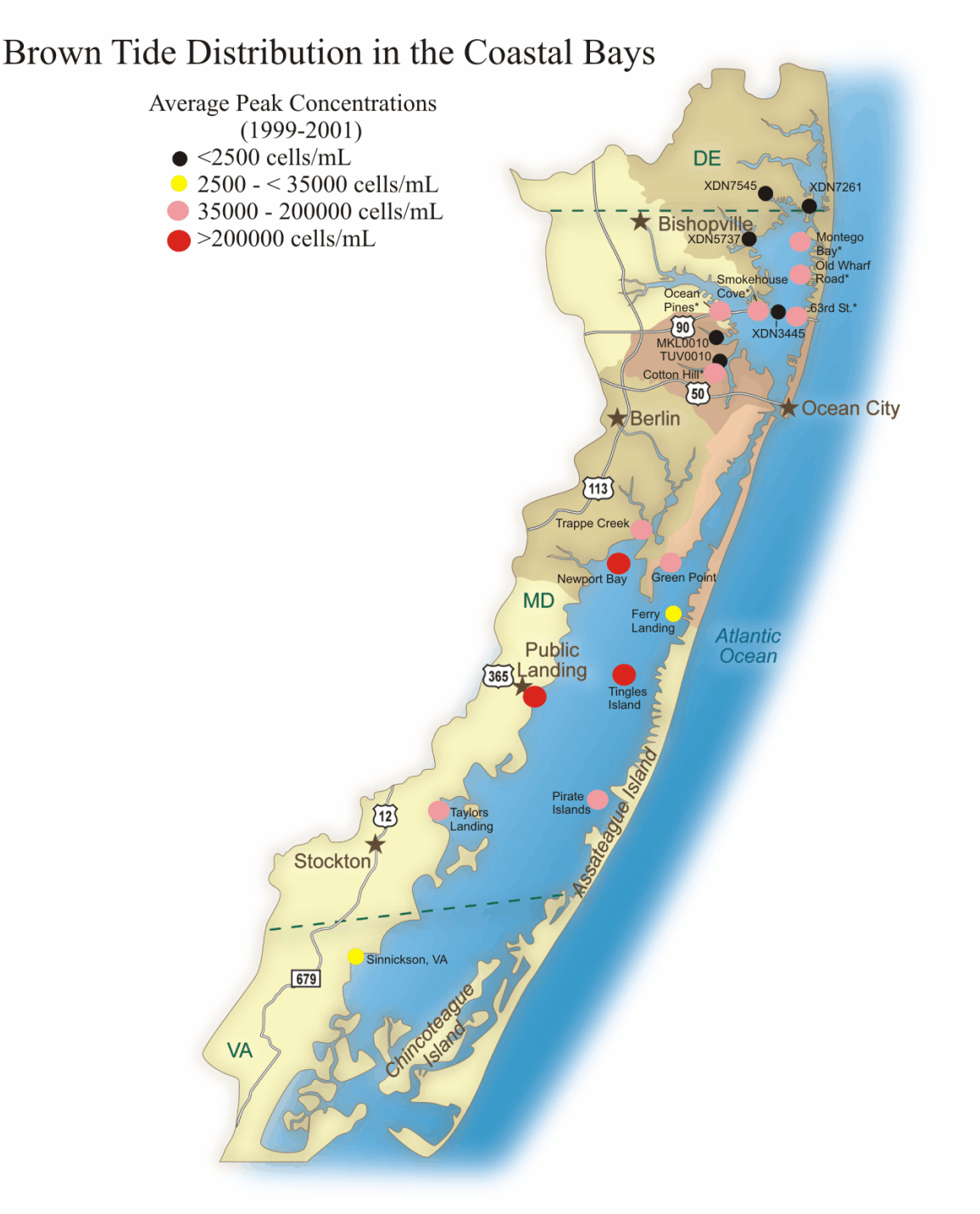

Figure 7.1.1: Average peak concentration of brown tide cells at each Coastal Bays sample station between 1999 and 2001.

Figure 7.1.2: Brown tide concentration at each Coastal Bays sample station during 1999.

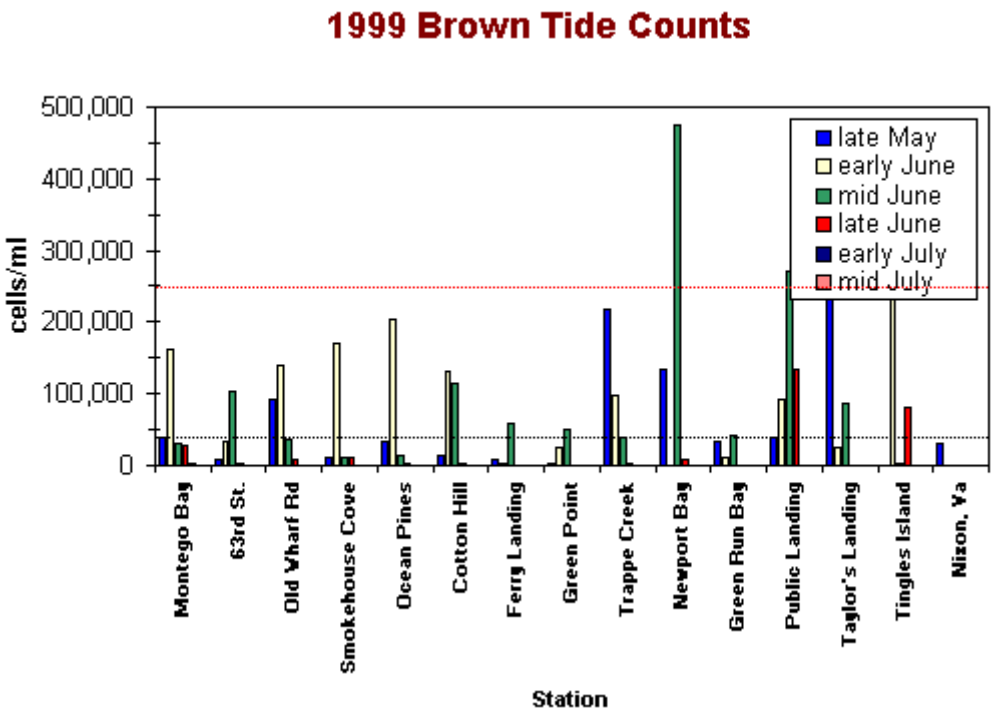

Figure 7.1.3: Brown tide concentration at each Coastal Bays sample station during 2000.

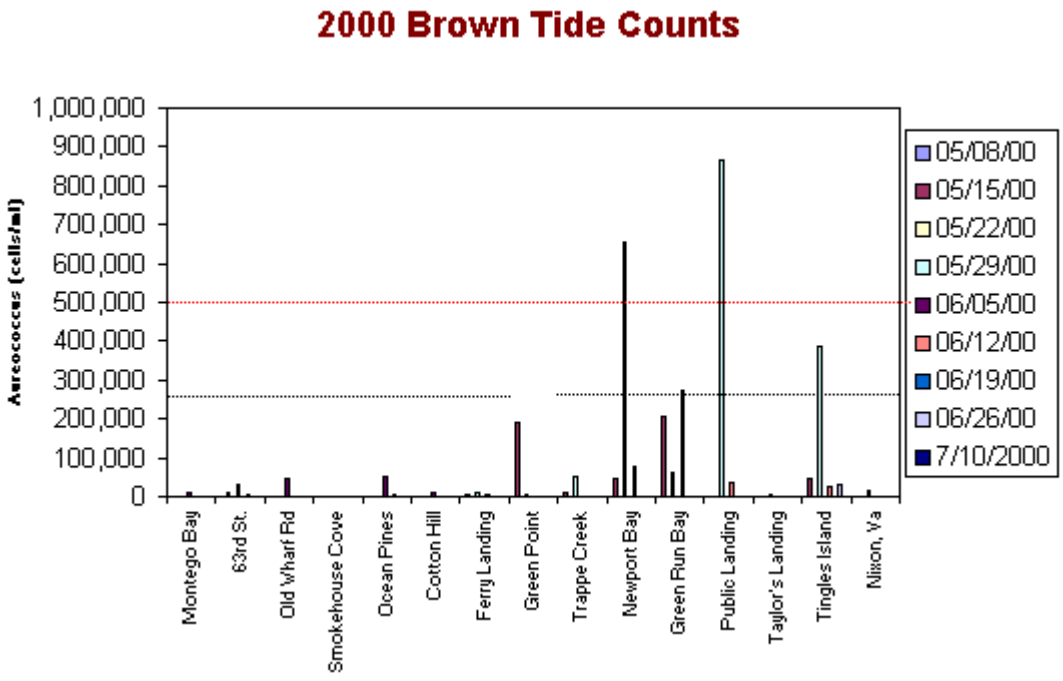

Figure 7.1.4: Brown tide concentration at each Coastal Bays sample station during 2001.

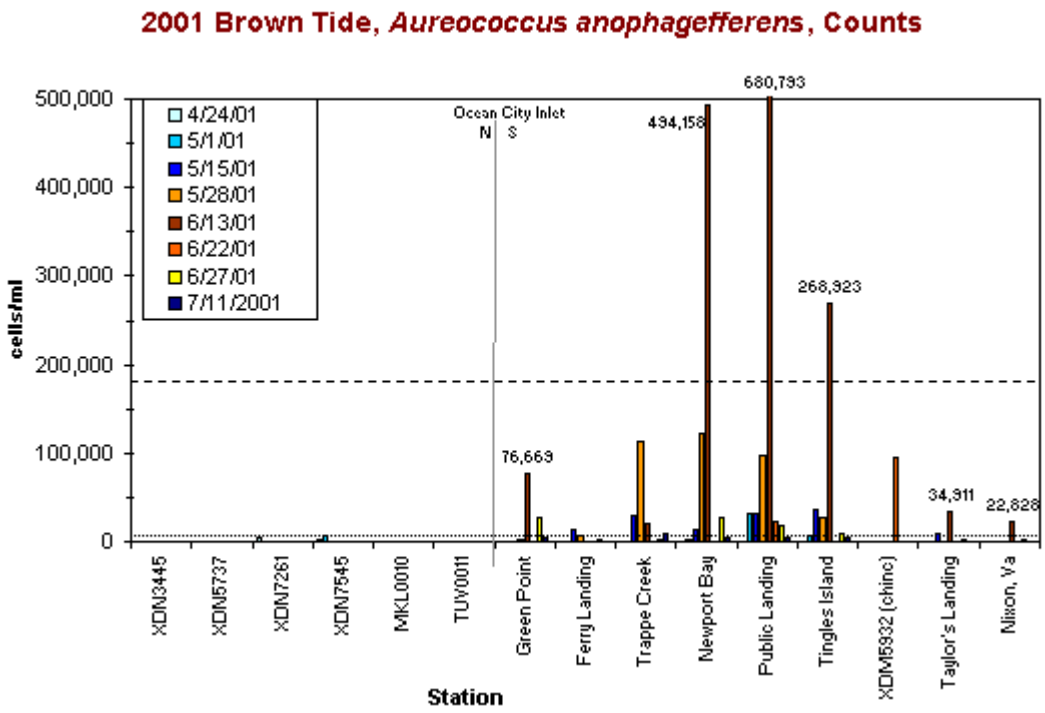

Figure 7.1.5: Brown tide concentration at each Coastal Bays sample station during 2002.

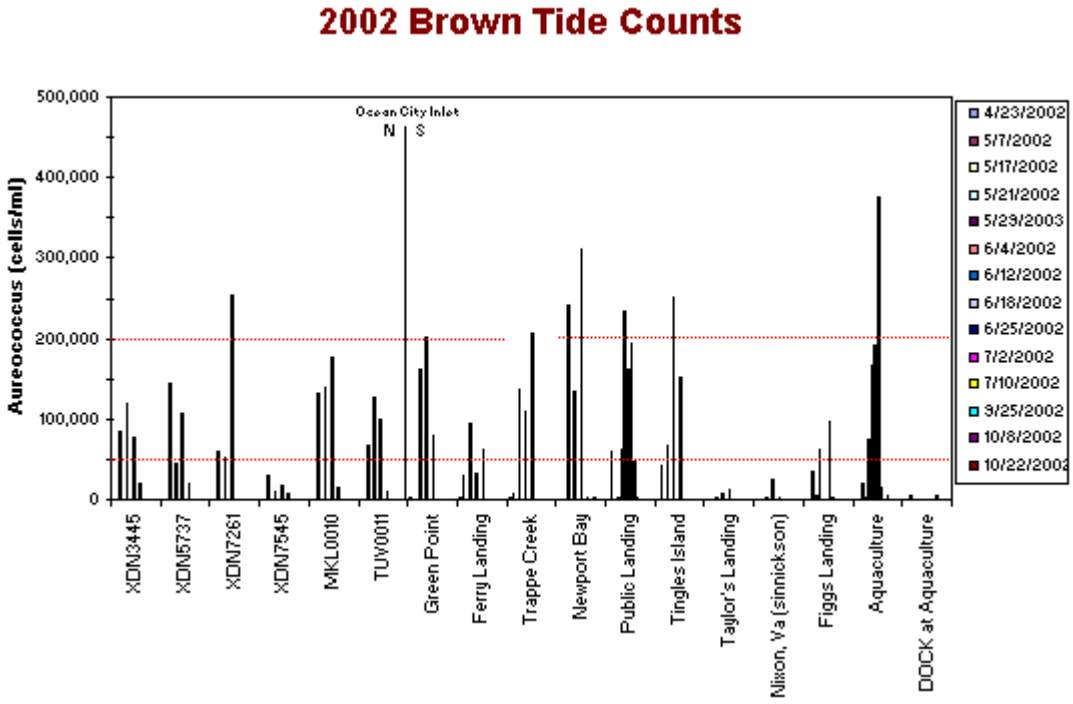

Figure 7.1.6: Brown tide concentration at each Coastal Bays sample station during 2003.